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Review Article

Digital Literacy in UK Health Education: What Can Be Learnt from International Research?

Barry Matthews
University of Gloucestershire, United Kingdom
ORCID: 0000-0001-7605-0694

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Abstract

Introduction: To meet the ambition of the UK becoming the global leader in health technology, the future workforce needs to have a developed digital literacy. The influence of the COVID-19 pandemic on the move to online learning has also increased the requirement for a reinvention of traditional teaching methodologies (Sá & Serpa, 2020).

Methodology: A systematic review was conducted using a mix of Boolean search terms in twelve education and health journal databases to discover the extent of current international research of digital literacy in health programmes. Papers were selected for their specificity to digital literacy in health education pre-registration professional programmes.

Results: The initial search included 5359 papers, 3925 after duplicates removed, 134 remained after title review which were then input into Covidence for full reading, finally 47 papers being included for thematic analysis. This thematic analysis identified a number of key themes within these papers: digital literacy of the educator, digital literate workforce, technical skills limit adoption, information literacy, a curriculum requirement in education, institutional infrastructure or personal access, preparedness for entering academia, concerns over the use of digital skills, personalised digital literacy experience, increased communication skills with digital literacies, competency frameworks, COVID-19 and social media in education.

Conclusion: This research identifies areas of good practice and areas that need to be considered in higher education programmes and by academics to ensure the digital literacy of the future healthcare workforce.

Keywords: health education, digital literacy, digital skills, technology enhanced teaching, health care, higher education

INTRODUCTION

A recent review commissioned by Health Education England (HEE) considered the evolving workforce in the National Health Service (NHS) (Topol, 2019). This report focused on the changes concerning the digital literacy requirements of the health workforce and makes predictions about the use of technology in health care towards 2040. These predictors require that the digital literacy levels need to increase significantly in the health care workforce prior to 2026. The Department for Health & Social Care (DHSC) have the ambition of the UK becoming the global leader in HealthTech (DHSC, 2018). To achieve this goal the DHSC describe the requirement for digital competence and the need for digital leaders to drive the workforce forward in this goal.

The HEE and the Royal College of Nursing (RCN) discuss how those with a developed digital literacy have a more positive attitude to adopting new technologies, and with the fast pace of technological advancement the entire health workforce needs to be prepared (HEE & RCN, 2017). For the continued delivery of

contemporary care, it is imperative that the health workforce is given the opportunity to learn and develop a digital literacy (Kennedy & Yaldren, 2017).

The NHS England and DHSC commissioned Wachter Report (2016) considered the educational requirements of the workforce. This report recommends that an allocation of £42 million be dedicated to the education of the current staff, 1% of the £4.2 billion planned budget for the digitalisation of the NHS. This report puts emphasis on the likelihood of failure of a digital health service without satisfactory financial and time investments into the training and development of the workforce who are going to be using it. The progress of technology in health care is still a vital component in the realisation of the NHS Long Term Plan (NHS, 2019); denoting again the importance of giving the staff that use technology the skills they need.

DIGITAL LITERACY IN HEALTH EDUCATION

The Topol Review (2019) also addresses the need to develop digital literacies in the future workforce. The review makes recommendations considering not only the inclusion of digital literacy into the curriculum, but also allow for the utilisation of digital literacies in assessment. The review puts responsibility on educational institutions to ensure that the graduating student leaves education with the appropriate level of digital literacy. There is further appreciation of the need for the involvement of health educators in the development of a digital NHS, building on the Wachter Report (2016) recommendations for completion prior to December 2017.

Introducing the skills for working within a health care environment, with such ambitions as being a world leader in HealthTech, during pre-registration education it is essential in ensuring that the future workforce is prepared for the expected exponential digitalisation of the NHS. As such, digital literacies are becoming a key element of curricula for students in health care, but also a core requirement for academics (Kennedy & Yaldren, 2017).

The development of digital literacies within pre-registration programmes may not be enough involvement from higher education institutions. With the continually evolving digital landscape, the production of a suitable Continuing Professional Development (CPD) series may be a further requirement to ensure the training and development of the current workforce. With lack of development being a major reason for attrition of the current workforce, targeting key areas that staff may feel they are left behind in may be crucial for staff retention (NHS, 2019).

The development of a curriculum for pre-registration curriculum should mirror that of the requirements of the workforce, and the higher education's leaders must take responsibility for this inclusion (Alexander et al., 2016). Curriculum guidance already reflects the required inclusion of digital literacies in pre-registration programmes in many roles. The Nursing and Midwifery Council (NMC) requiring digital skills to ensure safe and effective care (NMC, 2018); the Health and Care Professions Council (HCPC) require registering paramedics to be able to use information technologies appropriate to their practice (HCPC, 2014), with the College of Paramedics recommending further specific areas to develop, such as using the internet as an information source and the use of social media (College of Paramedics, 2017). The General Medical Council do not offer curriculum guidance of general digital literacies, but instead expect their registrants to be proficient in technology-enhanced learning for patients, and the legal aspects of digital record keeping (GMC, 2017). This list is not exhaustive, but an example of some of the expected skills at the point of leaving education and registering as a health care professional.

SYSTEMATIC REVIEW

The aim of this literature review to consider the themes in current academic literature around digital literacy in health education. Not only to consider the current knowledge of digital literacy in higher education for health programmes, but also discussions around the subject.

Table 1. Boolean Search terms used for database searches

Environment	Investigation
"health education"	"digital literacy"
"medic* education"	"digital skill*"
"higher education"[2]	"digital capabilit*"
	"digital proficien*"

Methodology

Boolean search terms were used to discover papers relating to digital literacies in higher education health programmes. This search was completed on the 26th of March 2021. Databases searched included ERIC; EBSCO Abstracts; EThOS; IngentaConnect; JSTOR; MEDLINE; ProQuest Education; RCNi[1]; SAGE; Science Direct; SCOPUS; Taylor & Francis; PUBMED. To discover papers a variety of versions of the environment and investigation ("[environment]" AND "[investigation]") was used to ensure an exhaustive search was completed (**Table 1**). The use of wildcard searches allowed for the exploration of variances in the keywords. No date or geographical restrictions were placed upon the search due to the expected low return.

The returned citations were downloaded in *.ris format and imported into Mendeley Reference Manager (Mendeley, 2008). Mendeley was used to consider papers by title. A further *.ris file was exported once this was complete, importing then into Covidence (Veritas Health Innovation, n.d.) to review by abstract, and then review the full paper. This was completed by the author solitarily. Initial database searches returned 5359 papers, of which 3925 were retained after duplicates removed. 428 papers remained at the end of the first title review with the evolution of inclusion and exclusion criteria recorded and therefore refined. 134 papers remained after exclusion by title at the second pass and were exported into Covidence for exclusion by abstract and full paper review. 47 papers were included in the study for thematic analysis (**Appendix 1**).

Inclusion criteria included health care related studies; higher education environment; digital (or synonym) literacies, capabilities, skills, or part thereof; any academic source. Additional exclusion criteria included letters to the editor; collected works or bibliographies; information literacy with no consideration to digital literacies. A single doctoral thesis (Evangelinos, 2018) was discovered from the EThOS database which was included in the thematic analysis.

Of the 23 papers excluded at full reading, reasons for exclusion included; considering a device or application in isolation, considering health care professionals in practice and not health care students, eHealth literacy and patient digital literacies. 4 of these were also excluded as policies or reports returned in the search which have been discussed earlier.

Analysis

Through this systematic review, a low return of research articles was identified (33), which was reflective of systematic reviews completed (Bembridge et al., 2010; Diane O'Doherty et al., 2018). 11 of the papers identified raised discussion around the topic of digital literacy in health education, with a small number of editorials included that also raise discussion. The majority of the papers were from medical education (21), with papers also discovered from nursing (11), health education as a general entity (10), allied health professions (2), midwifery (1), paramedic (1) and nursing and midwifery (1).

15 of the papers considered in this systematic review used the phrase 'digital literacy' to accurately describe the topic. 6 papers used the wording 'computer literacy', 5 used the wording 'computer skills', 5 considered 'information literacy' in its entirety and the word usage reflected this, 4 papers used 'digital skills', and the

[1] The RCNi database did not utilise Boolean search operators, so although the environment was changed, the investigation was kept to "digital literacy" which proved sufficient on contrast searches.
[2] "higher education" was used due to the specific nature of some the journals, chosen as health practice as their subject matter. This was also used in non-specific to health journals for consistency.

Table 2. Themes identified within this systematic review

Theme	Found in number of papers
Curriculum Requirement	16
Educators Digital Literacy Level	13
Information Literacy	11
Technical Skills	10
Digital Literacy Of The Workforce	9
Institutional Infrastructure	7
Personalised Development	6
Social Media	5
Concerns Over Digital Literacies	4
Student Experience	4
Communication Skills	4
Pre-Programme Requirement	3
COVID-19	2
Confidence	2
Practice Placement	1
Creativity	1
Enjoyment	1
Attrition	1
Autonomous Learning	1
Peer Learning	1
Competency Frameworks	1

final papers used the terms ‘digital competencies’, ‘ICT’, ‘ICT skills’, ‘information technology’ and ‘technology’.

The country that contributed the most was America (11), followed by the UK (9), Ireland (3), Australia (2), Spain (2) with single papers contributed from Austria, Canada, Denmark, Ethiopia, Germany, Hungary, India, Kuwait, Malaysia, Nigeria, Romania, Saudi Arabia, Singapore, South Africa, Sri Lanka, Sweden and Switzerland with three papers taking a global perspective.

THEMES IDENTIFIED

A number of major themes were identified and have been discussed individually; minor themes have been described as an integrated component of major themes. A theme was considered to be minor if only encountered in a single article (**Table 2**).

Digital Literacy Level of the Educator

The constantly changing digital environment was identified; and along with it, the requirement for the educator to continually develop their own digital literacy to ensure that the student receives the most contemporary education of the highest quality. This was reflected as early as 1983 (Beall, 1983), although some of the predicted skills, such as programming software, appear ambitious.

This requirement is still reflected in the more contemporary article, with O’Doherty et al. (2019) putting emphasis on the requirements of the faculty to keep up with the digital literacies of the students as they are developed during their time in academia. Although O’Doherty et al. (2019) did not find any significant difference in skills, this may be due to factors such as a lack of digital literacy development in both instances as similar difficulties were identified. O’Doherty et al. (2018) discovered that the insufficient digital skills of the educator can be a barrier for effective eLearning and that institutional support and training is required to ensure that this barrier is removed. For digital literacy to be embedded successfully in the curriculum, it is imperative that educators see the value. Support must be made available to educators so that they can develop their own literacy to pass on to the student.

Goh and Sandars (2019) consider the implications of the educator's digital literacy in providing the student with resources that are both applicable and appropriate. Goh and Sandars describe the requirement of a critical awareness of digital literacy and raise concerns over information overload if not controlled or taught in an effective way. Health educators will be essential in fulfilling the goals of the technologically advanced health care provisions of the future (Risling, 2017).

The importance of digital literacy in practice mentors was also identified by Hagdrup et al. (1999). With students spend a considerable amount of time in academia in practice placement, the learning and development of digital literacies in the student may be influenced by those whom they work with. The student may have the experience of utilising and learning workplace technologies if the practice mentor were confident in teaching them. Terry et al. (2019) describes the use of digital literacy champions for peer-to-peer support and teaching. The result of this was that the students also taught digital literacy skills to their mentors, and patients, as they felt enabled to do so.

COVID-19

A small number of papers (2) discussed the effect of COVID-19 directly on digital literacy. Cabero-Almenara et al. (2021) consider that there was a push to increase the digital literacy educators due to the pandemic and the move to a more online platform for learning. The COVID-19 pandemic was discussed by Carolan et al. (2020) in a guest editorial consider how the digital literacy of faculty staff and students has hindered the sudden and required move to online forms of delivery.

Digitally Literate Workforce

If education is to reflect the required skills for a registered professional, the content needs to be reflective of the future. Drivers for the digitally literate workforce within healthcare have already been discussed, and the uncertainty of future technologies require the student to be given the skills to adapt to this ever-changing environment (Risling, 2017). The building of digital literacies, over skills in a specific platform or even device, can encourage the student to adapt and overcome challenges presented when attempting to work in this dynamic environment. The expectations that a graduating professional should be motivated to utilise technology in their practice to improve patient care (Jacobs et al., 2017). López Peláez et al. (2020) discovered a gap in required and observed digital literacy on graduation in Social Work, which could be compared to other disciplines in health.

Technical Skills and Confidence Limit Technology Adoption

Students are known to access devices regularly, but not necessarily bring a laptop in a facilitated session in university (Gray et al., 2019). The increase in the use of technology has caused a branching of the devices used by students, and the devices brought with them. The use of smaller and more mobile devices may have replaced the use of larger, more cumbersome devices in the classroom. The use of these technologies is, as Tarrant (2018) describes, a foregone conclusion. Evangelinos and Holley (2014) describe that the student may consider themselves to have a high technical ability, but their skills and experience is narrowed and do not recognise their deficit. These devices can bridge the theory gap between knowledge acquisition and practice if used in an appropriate way, but it is important to acknowledge the limitations of devices and develop the technical literacies to use a multitude of technologies.

The students require the confidence to approach an ever-changing digital landscape with the confidence to be able to utilise the equipment presented to them (Jacobs et al., 2017). The development of self-efficacy will encourage the student to take part in the usage of a new digital resource without motivation drawn from the consideration of being unsuccessful in its use without instruction. Robertson and Felicilda-Reynaldo (2015) further relating their study to the works of Bandura (1986) on the consideration of self-efficacy and the motivation to use digital literacies in practice. If the student does not have the technical skills to see that they will succeed in a problem, it is likely that they will not attempt it.

Difficulties arise with the student's perception of the usefulness of technology (Kleinert & Stewart, 2007). If the student does not deem the technology to be useful in their current situation, they may not consider developing their skills in that area. The perception of relevance is essential in ensuring the students are motivated to learn and develop. This idea is not new, with Keller (1987) discussing how to motivate the student through the integration of the ARCS model into curriculum design.

Information Literacy

The expected knowledge base of a health professional is ever-expanding, and this knowledge cannot be taught in a typical undergraduate programme (Koschmann, 1995). With this identified over twenty years ago, it can only be assumed to be more of an issue as knowledge in health increases. Elf et al. (2015) further support this concern with student responses from a survey; with students stating they found it difficult to determine appropriate resources at the correct and expected level. Robertson and Felicilda-Reynaldo (2015) further reported that students, although show a high confidence in their own information literacy, did not perform particularly well in tasks related to database searching. This is further echoed by Purnell et al. (2020) discovering that the information literacy of nursing students was insufficient and Zupanic et al. (2019) that the media literacy of students varied between subjects. Purnell et al. discussed how curriculum integration of these skills is needed to improve, in addition suggesting linking information literacy to assessments. The amount of information available through web-based resources can cause an overload of information (Goh & Sandars, 2019) and a developed information literacy is required to ensure that the student uses the most appropriate information and resources.

There is an importance placed on the continued use of online learning once the student has graduated to keep up-to-date with recent changes in an ever-changing health care system (Ruggeri et al., 2013). The concerns raised over this continued professional development included the wealth of knowledge available and the potential for information overload, such as with the undergraduate student. In this instance a learnt and practised information literacy would decrease this burden.

A Curriculum Requirement in Academia

Development of digital literacy should commence in the early stages of academia, if left too late there is a risk that the skills for digital literacy will not be acquired and practised (Ranasinghe et al., 2012). Lim, Wong and Lim (2005) consider the use of digital technologies as a learning tool, and that to be used effectively these digital literacies must be developed; simply having the information available is not enough if the skill or motivation to access it is lacking. Link and Marz (2006) briefly describe how increased digital literacy may account for an increased readiness to utilise eLearning resources as an alternative to traditional classroom-based materials. Not only this, but students have self-reported enjoying improving their digital literacy, and using them in an academic context (Diane O'Doherty et al., 2018).

Oberprierler, Masters and Gibbs (2005) reported on their integration of IT skills-based sessions into the curricula. The authors reported that the students had identified their skill gaps and worked towards a rounded skill set. Through gaining the skills the students also discovered the growing requirement for future digital skills. Bembridge, Levett-Jones and Jeong (2010) consider that the digital literacies required of pre-registration nursing students are specialist and require a tailored programme over a standardised curriculum. This point was again raised with regard to medical education (Mesko et al., 2015). Barr et al. (2020) developed a framework to introduce Information Literacy education into the curriculum, within learning outcomes, assignments, assessments and learning activities. This framework is as-yet untested, but the importance of such curriculum integration is well discussed.

Although, it could be argued that a complete digital literacy would include transferability of skills to new or novel devices or software. Despite the prediction of Beall (1983), it is unlikely that a health educator (or student) will ever need to debug a code. O'Doherty et al. (2019) considered this also with health workers unlikely to require the skill of website creation, but still need to be taught how create content digitally and express themselves creatively. Hautz et al. (2020) describes four reasons for the lack of current curriculum inclusion; lack in support of development and implementation, lack of staff for coordination and planning,

budget and the lack of curricular content. Hautz et al. (2020) further describe that digital literacy of the educator may also be a limiting factor.

Institutional Infrastructure or Personal Access

The facilities available in an institution was reported to have an effect on the computer literacy of students in India (Aggarwal & Pandey, 2004). With initiatives for 'bring your own device' during taught campus-based sessions, the availability of infrastructure to support this should be considered. Providing sufficient power sockets in areas of learning and study is important to ensure that students have sufficient access to digital services (Thorell et al., 2015).

With the increase in personal device ownership, the relationship between computer access may be insignificant where the national infrastructure does not limit such ownership or usefulness of ownership. National infrastructure was identified as a limiting factor on computer ownership and interaction, this presents less of an issue in urbanised areas (Woreta et al., 2013). Instead of trying to tackle the issue during academia, the author describes an entry requirement for the medical programme is that the student must own their own computer. Ranasinghe et al. (2012) do further correlate digital literacy with computer ownership in Sri Lanka. Despite computer ownership of 80%, Ranasinghe et al. reported that only 15% of the students obtaining a digital literacy score comparable to students of a developed country.

Preparedness for Entering Academia

Pre-programme learning can be utilised to prepare a student for their first experiences in academia, increasing their effectiveness; possible reducing the need to start at the basics with students with little experience of digital literacy development (Craig & Corrall, 2007). Existing knowledge and skills should not be considered sufficient for academia (Oberprieler et al., 2005). Students may have been exposed to generic software prior to entering academia, but may need further training on more specialist software used in their speciality or commonplace in academia such as reference managers (Thorell et al., 2015). There is too much variation in the routes into higher education for the assumption to be made that the student's skills in digital literacy do not require development; including those students considered 'traditional entry'.

The use of prior learning when approaching both an undergraduate and graduate programme can have an impact on the attrition rates, discovering problems before they develop (Pintz & Posey, 2013). Buabbas, Al-Shawaf and Almajran (2016) discovered that the digital literacy of those entering academia was insufficient and that the introduction of a course in ICT did improve this but that additional practice was needed on the part of the student. Evangelinos (2018) found that an increased digital literacy improves the student experience. This increase in student experience from introducing digital literacies prior to starting a programme, and developing them during the programme, may have a marked effect on attrition and retention of students.

Concerns Over the Use of Digital Skills

With the increased use of digital literacies, it is important the student develop an online professional identity, and be aware of the ethical concerns and the policy and regulations that must be considered with accessible material creation (Popoiu et al., 2012). A professional social media identity can be useful in keeping up to date with current news in areas of interest, but it can be all too easy to passively breach data protection laws and policies (D O'Doherty et al., 2019). Although students may be aware of these issues (Evangelinos & Holley, 2014), the potential issues of even using closed-group communications could warrant adding additional instruction on data privacy and security (Hart et al., 2019).

Personalised Digital Literacy Experience

It can be difficult to cater to the needs of a full cohort with a range of levels of digital literacy (Hurst, 2014). Hurst suggests employing active participation and usage of digital devices to learn through practice. Another concern identified is that the requirements of post-graduate health students may not mirror those on an undergraduate programme. Health education students may complete an undergraduate degree, then return

to higher education after many years to develop their career. Pintz and Posey (2013) suggest that these students may require a different approach for their pre-programme learning material to prepare for postgraduate study after a study gap. Despite this, there is evidence that there is some improvement in digital literacy over undergraduate education (Holt et al., 2020), although offering no discussion of the source of this increase in digital literacy.

Increased Communication Skills with Digital Literacies

The use of digital communication resources presents opportunities for collaborative landscapes away from the classroom, such as in placement heavy health programmes, which can facilitate peer learning at a distance or being able to contact the academic team (Hart et al., 2019; Tarrant, 2018). For the student to see the benefit of such a tool, Hart et al. found that developing their digital literacy around communication technologies improved perceptions. The authors also discovered that this utilisation of collaborative tools gave encouragement for the student to use telehealth resources on completion of their studies. The added benefit of using digital communication includes allowing even the quietest of students to have a voice in the crown (Tarrant, 2018).

Social Media in Education

Social media can be a powerful tool that can encourage participation, increase student engagement, enhance reflective thinking and promote collaboration (Cole et al., 2017; Gao et al., 2012). This was discovered to be self-reported also on health student use of back-channel social media micro-blogging whilst on placement through the use of Twitter (Stockdale et al., 2019). The collaboration that safe and ethical use of social media and shared digital resources offer can reduce the distance between students whilst on placement; not only peer to peer, but also peer to academic. Stockdale et al. discussed how the effective use of social media created a personalised learning experience for the student. Although in itself the use of social media may not be a digital literacy, but the safe and effective use in a clinical context is.

Digital Literacy Assessment Frameworks

There are a large number of frameworks available for the assessment, self-evaluation, and improvement of digital literacy. Nazeha et al. (2020) authored a scoping review that discovered 30 digital literacy competency frameworks, of which 28 domains were identified. This scoping review found that no frameworks included all 28 domains, with the highest found to include only 21. The competency frameworks were based around relevance to a particular discipline, with nursing having the highest number. Nazeha et al. (2020) further suggest that these frameworks need to develop with the future development of healthcare.

There are a number of more generic frameworks for digital literacy competencies either aimed at health care, such as A Health and Care Digital Capabilities Framework (HEE, 2018), or the general public, such as the DigComp 2.0 framework (EU Science Hub, 2019). Despite the DigComp 2.0 framework being for generic use, it has been tested successfully in its use within healthcare professional practice (Evangelinos, 2018).

DISCUSSION

The data analysis identified that academics have a global interest in the digital literacy of health students. The approaches of some institutions were unique and reflective of their origin, some more rural, or less urbanised, shown that computer ownership was low and had a dramatic effect on digital literacies (Aggarwal & Pandey, 2004). There were papers that originated from a number of health subjects, showing a wider concern than solely one health discipline; but with the majority from a medical perspective leaving scope for more research in other disciplines. With the drivers for a digitally literate future workforce, inclusion as a curriculum component can be seen to be important to reach the goal of the UK workforce becoming the world leader in healthcare.

The thematic analysis for content of the digital literacy development of the health student heavily centred around information literacy and technical skills. These have been identified as important areas of

consideration in the development of student digital literacies, but do not represent the complete digital literacy. There are four other areas of digital literacy represented in the HEE and RCN guidance (HEE & RCN, 2017). The importance of the other areas of a digital literacy are not overly discussed in the literature, and no exploration as to why. For the student to develop a full digital literacy all areas must be considered for curriculum design and integration.

Personalisation of the curriculum for the development of digital literacy was evident in all themes identified. The individual development of digital literacy due to variance when entering Higher Education (Hurst, 2014) through to ensuring that the education is relevant to the students discipline such as in Nurse and Medical education (Bembridge et al., 2010; Mesko et al., 2015). Although there are discussions in the literature around the incorporation of digital literacies into a curriculum, making this a core institutional component may prove difficult to fully realise the personalisation of its content.

With many competency frames and domains that could be considered, the implementation of a process curriculum inclusive of self-evaluation may be more supportive through personalisation of learning. Although this would move away from the measurable objectives from a product curriculum, with the ever-changing digital landscape before the student it could be argued that a less prescriptive and more personalised education journey is needed. This process curriculum model approach allows for the 'multiple intelligences' (Alex, 2012), or this instance the differing levels of digital literacies and the personalised development.

CONCLUSION

Digital literacy has been shown to be an important consideration for the development of the future health care workforce. The evidence around the current provision, and discussion of points of consideration, is limited. With the driving forces for digital literacy to be embedded in pre-registration programmes, further research on the optimal implementation of such a curriculum should be completed. From before entering academia to post-academia, the development and improvement of the student's digital literacy is an important consideration for academics and the aspiring health professional. Any curriculum or taught inclusion must consider the dynamic, disruptive and progressive nature of digital technology, and suitably prepare the student for exposure to it both during their studies and their future vocation. This study has identified that the digital literacy of the educator may be a contributing factor to current gaps in digital literacy in students and lack of curricular content. Support from institutions, in knowledge, innovation and infrastructure, to support academics to develop is required to overcome this hurdle.

LIMITATIONS TO THE STUDY

The main consideration when completing this systematic review was the lack of consistency in terminology. Digital literacy has long been considered the correct terminology to describe the skill set that makes an individual competent in all areas of a digital world. There is a marked increase in the use of digital literacy as the correct terminology, but there is still use of other descriptors. The term digital literacy was first introduced by Gilster (1998), but the modernisation of definitions and relations to working and living in a digital environment has popularised this terminology. Although due to the nature of some of the databases utilised the term 'computer' or other variants of the term digital literacy were returned, attempts at an exhaustive search may be futile due to the use of terminology.

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Hautz, S. C., Hoffmann, M., Exadaktylos, A. K., Hautz, W. E., & Sauter, T. C. (2020). Digital competencies in medical education in Switzerland: an overview of the current situation. *GMS Journal for Medical Education*, *37*(6), Doc62. https://doi.org/10.3205/zma001355

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Terry, J., Davies, A., Williams, C., Tait, S., & Condon, L. (2019). Improving the digital literacy competence of nursing and midwifery students: A qualitative study of the experiences of NICE student champions. *Nurse Education in Practice*, *34*, 192-198. https://doi.org/10.1016/j.nepr.2018.11.016

Thorell, M., Fridorff-Jens, P. K., Lassen, P., Lange, T., & Kayser, L. (2015). Transforming students into digital academics: A challenge at both the individual and the institutional level Approaches to teaching and learning. *BMC Medical Education*, *15*(1). https://doi.org/10.1186/s12909-015-0330-5

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Woreta, S. A., Kebede, Y., & Zegeye, D. T. (2013). Knowledge and utilization of information communication technology (ICT) among health science students at the University of Gondar, North Western Ethiopia. *BMC Medical Informatics and Decision Making*, *13*, 31. https://doi.org/10.1186/1472-6947-13-31

Zupanic, M., Rebacz, P., & Ehlers, J. P. (2019). Media use among students from different health curricula: Survey study. *JMIR Medical Education*, *5*(2), e12809. https://doi.org/10.2196/12809

Correspondence: Barry Matthews, University of Gloucestershire, United Kingdom.
E-mail: bmatthews1@glos.ac.uk

APPENDIX 1

Thematic and Content Systematic Review Output Record by Date of Publication Then Surname of Lead Author

Citation	Discipline	Country	Article Type	Descriptor	Themes Discovered
Beall, B. S. (1983). Computer literacy for health educators. *Health Education*, *14*(6), 19-22. https://doi.org/10.1080/00970050.1983.10628764	Health	America	Discussion	Computer Literacy	Curriculum Requirements
Koschmann, T. (1995). Medical education and computer literacy: learning about, through, and with computers. *Academic Medicine: Journal of the Association of American Medical Colleges*, *70*(9), 818-821. https://doi.org/10.1097/00001888-199509000-00020	Medicine	America	Discussion	Computer Literacy	Digitally Literate Workforce; Technical Skills; Information Literacy
Blue, A. V, Witzke, D., Bonaminio, G., Fitzgerald, D., Ramsbottom-Lucier, M., Rubeck, R., & Nora, L. M. (1998). Kentucky physicians' perspectives and preparedness for computing in medical education and practice. *The Journal of the Kentucky Medical Association*, *96*(10), 405-409.	Medicine	America	Research	Computer Skills	Technical Skills
Austin, S. (1999). Baccalaureate nursing faculty performance of nursing computer literacy skills and curriculum integration of these skills through teaching practice. *Journal of Nursing Education*, *38*(6), 260-266. https://doi.org/10.3928/0148-4834-19990901-06	Nursing	America	Research	Computer Literacy	Educators Digital Literacy Level; Digitally Literate Workforce
Hagdrup, N. A., Edwards, M., Carter, Y. H., Falshaw, M., Gray, R. W., & Sheldon, M. G. (1999). Why? What? and How? IT provision for medical students in general practice. *Medical Education*, *33*(7), 537-541. https://doi.org/10.1046/j.1365-2923.1999.00350.x	Medicine	UK	Discussion	Computer Literacy	Digitally Literate Workforce; Information Literacy; Practice Mentorship
Mansoor, I. (2002). Computer skills among medical learners: a survey at King Abdul Aziz University, Jeddah. *Journal of Ayub Medical College, Abbottabad: JAMC*, *14*(3), 13-15.	Medicine	Saudi Arabia	Research	Computer Skills	Digitally Literate Workforce; Information Literacy
Aggarwal, R., & Pandey, R. (2004). Information technology and medical education in India. *The National Medical Journal of India*, *17*(1), 5-7.	Medicine	India	Editorial	Information Technology	Curriculum Requirement; Institutional Infrastructure
Lim, T. A., Wong, W. H., & Lim, K. Y. (2005). Perceived skill and utilisation of information technology in medical education among final year medical students, Universiti Putra Malaysia. *The Medical Journal of Malaysia*, *60*(4), 432-440.	Medicine	Malaysia	Research	Computer Skills	Curriculum Requirement; Personalisation of Digital Literacy
Oberprieler, G., Masters, K., & Gibbs, T. (2005). Information technology and information literacy for first year health sciences students in South Africa: matching early and professional needs. *Medical Teacher*, *27*(7), 595-598. https://doi.org/10.1080/01421590500062723	Medicine	South Africa	Research	Information Literacy	Curriculum Requirement; Pre-Programme Requirement; Personalisation of Digital Literacy
Link, T. M., & Marz, R. (2006). Computer literacy and attitudes towards e-learning among first year medical students. *BMC Medical Education*, *6*, 34. https://doi.org/10.1186/1472-6920-6-34	Medicine	Austria	Research	Computer Literacy	Curriculum Requirement
Craig, A., & Corrall, S. (2007). Making a difference? Measuring the impact of an information literacy programme for pre-registration nursing students in the UK. *Health Information and Libraries Journal*, *24*(2), 118-127. https://doi.org/10.1111/j.1471-1842.2007.00688.x	Nursing	UK	Research	Information Literacy	Pre-Programme Requirement
Kleinert, J. O., & Stewart, S. R. (2007). The need for technical literacy in doctoral education: a preliminary survey. *Journal of Allied Health*, *36*(2), 88-100.	Allied Health	America	Research	Technology	Digitally Literate Workforce; Technical Skills; Personalisation of Digital Literacy; Social Media
Bembridge, E., Levett-Jones, T., & Jeong, S. Y.-S. (2010). DISCUSSION PAPER: The preparation of technologically literate graduates for professional practice. In *Contemporary Nurse* (Vol. 35). https://doi.org/10.5172/conu.2010.35.1.018	Nursing	Australia	Discussion	ICT	Curriculum Requirement
Fadeyi, A., Desalu, O. O., Ameen, A., & Adeboye, A. N. M. (2010). The reported preparedness and disposition by students in a Nigerian university towards the use of information technology for medical education. *Annals Of African Medicine*, *9*(3), 129-134. https://doi.org/10.4103/1596-3519.68358	Medicine	Nigeria	Research	Computer Skills	Curriculum Requirements
Popoiu, M. C., Grosseck, G., & Holotescu, C. (2012). What do We Know about the Use of Social Media in Medical Education? *Procedia - Social and Behavioral Sciences*, *46*, 2262-2266. https://doi.org/10.1016/j.sbspro.2012.05.466	Medicine	Romania	Discussion	Digital Skills	Educators Digital Literacy Level; Concerns Over Digital Literacies; Social Media
Ranasinghe, P., Wickramasinghe, S. A., Pieris, W. R., Karunathilake, I., & Constantine, G. R. (2012). Computer literacy among first year medical students in a developing country: a cross sectional study. *BMC Research Notes*, *5*, 504. https://doi.org/10.1186/1756-0500-5-504	Medicine	Sri Lanka	Research	Computer Literacy	Institutional Infrastructure

Citation	Discipline	Country	Article Type	Descriptor	Themes Discovered
Sandars, J. (2012). Technology and the delivery of the curriculum of the future: Opportunities and challenges. *Medical Teacher*, *34*(7), 534-538. https://doi.org/10.3109/0142159X.2012.671560	Medicine	UK	Discussion	Digital Literacy	Educators Digital Literacy Level
Armstrong, A. D., & Jarvis-Selinger, S. (2013). I feel disconnected: learning technologies in resident education. *Instructional Course Lectures*, *62*, 577-585.	Medicine	America	Discussion	Digital Literacy	Educators Digital Literacy Level; Curriculum Requirement
Pintz, C., & Posey, L. (2013). Preparing students for graduate study: An eLearning approach. *Nurse Education Today*, *33*(7), 734-738. https://doi.org/10.1016/j.nedt.2012.11.020	Nursing	America	Research	Digital Literacy	Personalisation of Digital Literacies; Reduction In Attrition Rates
Woreta, S. A., Kebede, Y., & Zegeye, D. T. (2013). Knowledge and utilization of information communication technology (ICT) among health science students at the University of Gondar, North Western Ethiopia. *BMC Medical Informatics and Decision Making*, *13*, 31. https://doi.org/10.1186/1472-6947-13-31	Health	Ethiopia	Research	ICT Skills	Technical Skills; Institutional Infrastructure
Evangelinos, G., & Holley, D. (2014). A qualitative exploration of the EU digital competence (DIGCOMP) framework: A case study within healthcare education. *Lecture Notes of the Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, LNICST*, Vol. 138, pp. 85-92. https://doi.org/10.1007/978-3-319-13293-8_11	Health	UK	Research	Digital Competency	Concerns; Student Experience; Personalisation of Digital Literacies
Hurst, E. J. (2014). Educational technologies in health sciences libraries: Teaching technology skills. *Medical Reference Services Quarterly*, *33*(1), 102-108. https://doi.org/10.1080/02763869.2013.866494	Health	America	Discussion	Digital Literacy	Educators Digital Literacy Level; Personalisation of Digital Literacies
Elf, M., Ossiannilsson, E., Neljesjö, M., & Jansson, M. (2015). Implementation of open educational resources in a nursing programme: experiences and reflections. *Open Learning: The Journal of Open, Distance and e-Learning*, *30*(3), 252-266. https://doi.org/10.1080/02680513.2015.1127140	Nursing	Sweden	Research	Digital Literacy	Information Literacy
Mesko, B., Győrffy, Z., & Kollár, J. (2015). Digital literacy in the medical curriculum: A course with social media tools and gamification. *JMIR Medical Education*, *1*(2), e6-e6. https://doi.org/10.2196/mededu.4411	Medicine	Hungary	Research	Digital Literacy	Digitally Literate Workforce; Curriculum Requirement; Social Media
Robertson, S., & Felicilda-Reynaldo, R. F. D. (2015). Evaluation of graduate nursing students' information literacy self-efficacy and applied skills. *Journal of Nursing Education*, *54*, S26-S30. https://doi.org/10.3928/01484834-20150218-03	Nursing	America	Research	Information Literacy	Digitally Literate Workforce; Information Literacy; Curriculum Requirement; Confidence
Thorell, M., Fridorff-Jens, P. K., Lassen, P., Lange, T., & Kayser, L. (2015). Transforming students into digital academics: A challenge at both the individual and the institutional level approaches to teaching and learning. *BMC Medical Education*, *15*(1). https://doi.org/10.1186/s12909-015-0330-5	Health	UK	Research	Not mentioned	Institutional Infrastructure
Buabbas, A. J., Al-Shawaf, H. M. H., & Almajran, A. A. (2016). Health sciences students' self-assessment of information and communication technology skills and attitude toward e-Learning. *JMIR Medical Education*, *2*(1), e9. https://doi.org/10.2196/mededu.5606	Health	Kuwait	Research	ICT	Technical Skills; Curriculum Requirement
Cole, D., Rengasamy, E., Batchelor, S., Pope, C., Riley, S., & Cunningham, A. M. (2017). Using social media to support small group learning. *BMC Medical Education*, *17*(1). https://doi.org/10.1186/s12909-017-1060-7	Medicine	UK	Research	Digital Literacy	Educators Digital Literacy Level; Information Literacy; Social Media
Jacobs, R. J., Iqbal, H., Rana, A. M., Rana, Z., & Kane, M. N. (2017). Predictors of Osteopathic Medical Students' Readiness to Use Health Information Technology. *The Journal of the American Osteopathic Association*, *117*(12), 773-781. https://doi.org/10.7556/jaoa.2017.149	Medicine	America	Research	Computer Skills	Digitally Literate Workforce; Technical Skills; Information Literacy
Risling, T. (2017). Educating the nurses of 2025: Technology trends of the next decade. *Nurse Education in Practice*, *22*, 89-92. https://doi.org/10.1016/j.nepr.2016.12.007	Nursing	Canada	Discussion	Digital Literacy	Digitally Literate Workforce; Technical Skills
Haag, M., Igel, C., & Fischer, M. R. (2018). Digital Teaching and Digital Medicine: A national initiative is needed. *GMS Journal for Medical Education*, *35*(3), Doc43-Doc43.	Medicine	Germany	Editorial	Not Mentioned	Pre-Programme Requirement
O'Doherty, D., Dromey, M., Lougheed, J., Hannigan, A., Last, J., & McGrath, D. (2018). Barriers and solutions to online learning in medical education - an integrative review. *BMC Medical Education*, *18*(1), 130. https://doi.org/10.1186/s12909-018-1240-0	Medicine	Ireland	Research	Digital Skills	Educators Digital Literacy Level; Institutional Infrastructure; Enjoyment
Tarrant, B. (2018). Real and relevant: using web 2.0 social media technology to deepen and generalise learning in the health sciences and bridge the theory-practice gap. *Physical Therapy Reviews*, *23*(1), 61-67. https://doi.org/10.1080/10833196.2018.1447258	Allied Health	Australia	Research	Digital Literacy	Technical Skills; Curriculum Requirement; Concerns; Communication Skills; Social Media

Citation	Discipline	Country	Article Type	Descriptor	Themes Discovered
Hart, T., Bird, D., & Farmer, R. (2019). Using blackboard collaborate, a digital web conference tool, to support nursing students placement learning: A pilot study exploring its impact. *Nurse Education In Practice*, *38*, 72-78. https://doi.org/10.1016/j.nepr.2019.05.009	Nursing	UK	Research	Digital Literacy	Technical Skills; Concerns; Social Media
Goh, P. S., & Sandars, J. (2019). Increasing tensions in the ubiquitous use of technology for medical education. *Medical Teacher*, *41*(6), 716-718. https://doi.org/10.1080/0142159X.2018.1540773	Medicine	Singapore	Discussion	Digital Literacy	Educators Digital Literacy Level; Information Literacy
O'Doherty, D., Lougheed, J., Hannigan, A., Last, J., Dromey, M., O'Tuathaigh, C., & McGrath, D. (2019). Internet skills of medical faculty and students: Is there a difference? *BMC Medical Education*, *19*(1). https://doi.org/10.1186/s12909-019-1475-4	Medicine	Ireland	Research	Digital Skills	Educators Digital Literacy Level; Technical Skills; Curriculum Requirement; Concerns; Communication Skills; Creative Skills
Stockdale, J., Hughes, C., Stronge, S., & Birch, M. (2019). Motivating midwifery students to digitalise their enquiry-based learning experiences: An evaluative case study. *Studies in Educational Evaluation*, *60*, 59-65. https://doi.org/10.1016/j.stueduc.2018.11.006	Midwifery	Ireland	Research	Digital Literacy	Technical Skills; Social Media; Autonomous Learning
Terry, J., Davies, A., Williams, C., Tait, S., & Condon, L. (2019). Improving the digital literacy competence of nursing and midwifery students: A qualitative study of the experiences of NICE student champions. *Nurse Education in Practice*, *34*, 192-198. https://doi.org/10.1016/j.nepr.2018.11.016	Nursing/ Midwifery	UK	Research	Digital Literacy	Information Literacy; Pre-Programme Requirement; Peer Leaning
Zupanic, M., Rebacz, P., & Ehlers, J. P. (2019). Media Use Among Students From Different Health Curricula: Survey Study. *JMIR Medical Education*, *5*(2), e12809. https://doi.org/10.2196/12809	Health	Germany	Research	Not Mentioned	Educators Digital Literacy Level
Barr, N. C., Lord, B., Flanagan, B., & Carter, R. (2020). Developing a Framework to Improve Information and Digital Literacy in a Bachelor of Paramedic Science Entry-to-Practice Program. In *College & Research Libraries* (Vol. 81, Issue 6, pp. 945-980). https://doi.org/10.5860/crl.81.6.945	Paramedic	USA	Research	Digital Literacy	Information Literacy; Curriculum Requirement
Carolan, C., Davies, C. L., Crookes, P., McGhee, S., & Roxburgh, M. (2020). COVID 19: Disruptive impacts and transformative opportunities in undergraduate nurse education. *Nurse Education in Practice*, *46*, 102807. https://doi.org/10.1016/j.nepr.2020.102807	Nursing	UK	Editorial	Not Mentioned	COVID-19; Institutional Infrastructure
Hautz, S. C., Hoffmann, M., Exadaktylos, A. K., Hautz, W. E., & Sauter, T. C. (2020). Digital competencies in medical education in Switzerland: an overview of the current situation. *GMS Journal for Medical Education*, *37*(6), Doc62. https://doi.org/10.3205/zma001355	Medicine	Switzerland	Research	Digital Competence	Educators Digital Literacy Level; Curriculum Requirement
Holt, K. A., Overgaard, D., Engel, L. V., & Kayser, L. (2020). Health literacy, digital literacy and eHealth literacy in Danish nursing students at entry and graduate level: A cross sectional study. *BMC Nursing*, *19*(1). https://doi.org/10.1186/s12912-020-00418-w	Nursing	Denmark	Research	Digital Literacy	Confidence
Nazeha, N., Pavagadhi, D., Kyaw, B. M., Car, J., Jimenez, G., & Car, L. T. (2020). A Digitally Competent Health Workforce: Scoping Review of Educational Frameworks. In *Journal of Medical Internet Research* (Vol. 22, Issue 11). JMIR Publications Inc. https://doi.org/10.2196/22706	Health	Global	Research	Digital Competence	Digital Literacy Assessment Frameworks
Palacios-Rodríguez, A. (2021). The Teaching Digital Competence of Health Sciences Teachers. A Study at Andalusian Universities (Spain). *International Journal of Environmental Research and Public Health*, *18*(5), 2552. https://doi.org/10.3390/ijerph18052552	Health	Spain	Research	ICT	COVID-19; Educators Digital Literacy Level; Institutional Infrastructure
Purnell, M., Royal, B., & Warton, L. (2020). Supporting the development of information literacy skills and knowledge in undergraduate nursing students: An integrative review. *Nurse Education Today*, *95*, 104585. https://doi.org/10.1016/j.nedt.2020.104585	Nursing	Global	Research	Not Mentioned	Information Literacy; Curriculum Requirement